NUMERICAL STUDY OF A FALLING FILM AND WATER SPRAYS FOR THERMAL SHIELDING

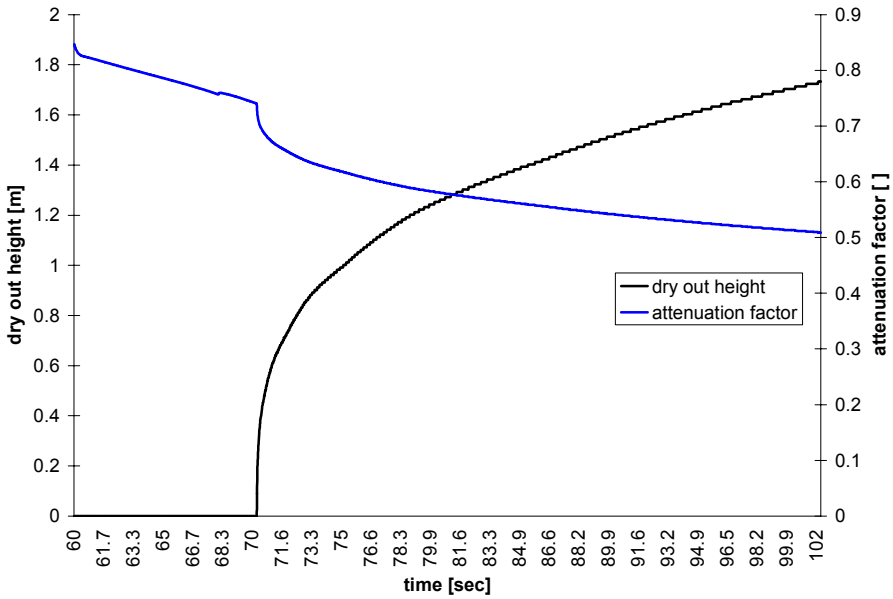
Panagiotis Karamertzanis, Greece
Supervisor: J.-M.Buchlin

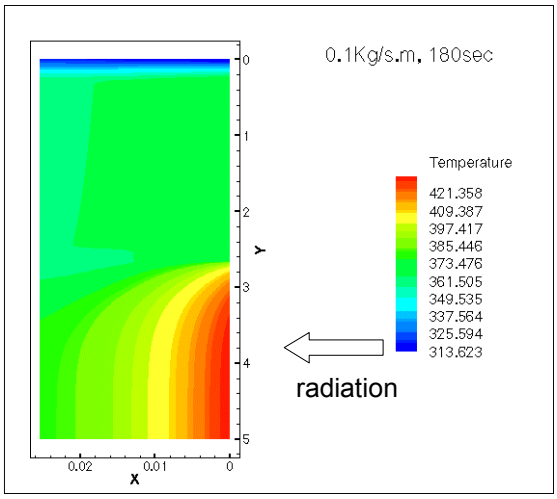
The main goal of this work is to predict the effectiveness of falling film and impinging sprays as a shield against thermal radiation. The conclusions can be used to develop more effective devices to mitigate fire consequences in petro-chemical industries.

The objective of the project is the development of an engineering code to predict the thermal behavior of falling films and sprays as a means against thermal radiation. Water has a high absorption coefficient that leads to strong attenuation of the incident radiation. On the other hand the formation of liquid films can cool down a previously exposed surface, due to high heat transfer coefficients. From the above considerations it is obvious that the rate at which heat is added to the formed liquid film can lead to strong evaporation and even boiling. In many cases, when the incident radiation exceeds a certain limit complete evaporation can occur. If that is the case the surface remains locally unprotected and the direct exposure to radiation results to sudden increase of temperature.

In many cases the incident radiation is not uniform, because the view factor of each part of the tank wall with respect to the fire can be different from nearby points. The model can account for this and allows the simulation of experiments for validation purposes. All necessary heat transfer modes, such as forced convection, free convection, radiation absorption and reflection, natural evaporation and boiling are taken into account. Moreover, the equation for the unsteady heat conduction in the tank wall is solved in three dimensions, allowing the prediction of the temperature in the internal surface. This surface is in touch with the flammable product and its temperature will determine whether a predefined safety limit has been reached or not.

The simulation and the results from the experiments, performed at the VKI spray facility, are in good agreement. The code is also used to predict the thermal behaviour of falling films and sprays in real case applications.





Inadequate protection with falling film (0.1kg/sm for incident radiation due to fire at 1200K)